

The Role of Phonological Awareness and Working Memory in Reading Performance: A Cognitive Psychological Study of Third and Fourth Grade Primary School Students

Guelif Ahlem ¹, Boudiba Rabah ²

¹ Laboratory of Psychological and Educational Applications — Constantine 2 University, Algeria

Email: a.guelif@univ-skikda.dz

² Faculty of Social and Human Sciences University of 20 August 1955 Skikda , Algeria

Email: r.boudiba@univ-skikda.dz

Received: 23/04/2026 ; Accepted: 26/08/2026 ; Published: 17/09/2026

Abstract:

This study examined the relationship between phonological awareness, working memory, and reading performance among 200 third- and fourth-grade primary school students in Ain Fakroun, Oum El Bouaghi Province, using a descriptive correlational predictive approach. Data were collected through tests of phonological awareness, working memory, and reading performance, with satisfactory reliability coefficients (Cronbach's alpha = 0.818–0.915).

The results revealed significant positive correlations ($p < 0.01$) between phonological awareness, working memory, and reading performance. Multiple regression analysis showed that phonological awareness and working memory explained 75.4% of the variance in reading performance, with working memory being the strongest predictor. No significant gender differences were found, while fourth-grade students performed significantly better than third-grade students.

The study emphasizes the importance of developing phonological awareness and working memory to enhance reading proficiency in primary education.

Keywords: Phonological Awareness, Working Memory, Reading, Reading Performance.

1. Introduction:

Learning and academic performance in all areas are based on the fundamental talent of reading. Cognitive psychology and educational science have placed a strong emphasis on understanding how children learn to read. Phonological awareness and working memory are two of the main cognitive processes that underlie reading performance; both are essential for decoding, comprehension, and fluent reading.

The ability to identify and work with language's phonemes, syllables, and rhymes is known as phonological awareness. It helps kids make the connection between written symbols and sounds, which is crucial for spelling and word identification. Conversely, working memory refers to the ability to momentarily store and process information while doing cognitive tasks, such as reading. By enabling the reader to remember and incorporate information from sentences and paragraphs, it enhances comprehension.

Numerous studies have demonstrated a strong correlation between reading difficulties and deficiencies in working memory or phonological awareness, especially in the early phases of literacy

development. Nonetheless, research on how these two cognitive elements interact and how that relationship affects reading ability is still ongoing.

Thus, the purpose of this study is to investigate the connection between reading performance, working memory, and phonological awareness in third and fourth grade elementary school pupils. By concentrating on this developmental stage, the study aims to improve literacy outcomes by offering greater insights into how cognitive processes influence reading abilities.

1.1. Problem Of Study:

One of the most essential abilities that students use to gain knowledge and hone their critical thinking abilities is reading. At all educational levels, it is a fundamental component of academic achievement. Even though reading is so important, many elementary school pupils struggle to learn and become proficient readers, which has a detrimental effect on their academic achievement.

Both working memory and phonological awareness are essential for the development of reading skills, according to recent cognitive psychology research. While working memory aids in processing, connecting, and analyzing textual information while reading, phonological awareness helps comprehend the connection between sounds and written symbols.

However, it is still unclear how these two cognitive factors relate to one another and how much of an impact they have on elementary school students' reading performance. This calls for more investigation and analysis, particularly during the transitional phases from learning to read to using it for comprehension and achievement. Our current study seeks to answer the following main question:

What is the role of phonological awareness and working memory in the reading performance of third and fourth grade elementary school students?

From this main question arise a set of sub-questions:

- What is the relationship between phonological awareness, working memory, and reading performance among third and fourth grade students?
- Are there differences in the level of phonological awareness, working memory, and reading performance among third and fourth grade students according to gender?
- Are there differences in the level of phonological awareness, working memory, and reading performance among third and fourth grade students according to grade level?

1.2. Study Hypotheses:

The study seeks to test the following hypotheses:

- There is a statistically significant relationship at the (0.01) level between phonological awareness, working memory and reading performance among primary school students.
- There are statistically significant differences at the (0.05) level in reading performance attributable to demographic variables (gender and grade level) among primary school students.
- Phonological awareness and working memory contribute to predicting reading performance among third and fourth grade elementary school students.

1.3. The Importance Of The Study:

- **Theoretical importance:** This study extends and complements the theoretical foundation of previous studies that addressed the variables of phonological awareness and working memory

and their relationship to the reading process. It will contribute to current knowledge by shedding light on the role of phonological awareness and working memory in developing the reading performance of elementary school students.

- **Applied importance:** Identifying the relationship between phonological awareness and working memory and their role in enhancing the reading performance of third and fourth grade elementary school students will guide future research towards developing appropriate programs aimed at improving the reading performance of these students. Furthermore, this study includes tools for measuring the variables of phonological awareness, working memory, and reading performance, which may be beneficial to researchers in other studies.

1.4. Study Objects:

This study aims to identify the role of phonological awareness and working memory in the reading performance of primary school students by achieving the following specific objectives:

- To determine the level of phonological awareness, working memory, and reading performance among third and fourth grade students.
- To reveal the nature of the correlation between phonological awareness, working memory, and reading performance among students.
- To analyze the extent to which phonological awareness and working memory contribute to predicting reading performance using multiple regression analysis.
- To identify differences in the level of phonological awareness, working memory, and reading performance according to gender (male/female).
- To identify differences in the level of phonological awareness, working memory, and reading performance according to grade level (third/fourth).
- To provide educational recommendations based on the study's findings to support the development of reading skills by enhancing phonological awareness and working memory in the primary school learning environment.

1.5. Study Scope:

- **Spatial Scope:** The study was limited to three primary schools in the city of Ain Fakroun, in the province of Oum El Bouaghi: the 20 August 1955 School, the Lchatr El Oued School, and the Siya Tayeb School.
- **Personnel Scope:** The study was limited to third and fourth grade primary school students.
- **Thematic Scope:** The study focused on investigating the relationship between phonological awareness, working memory, and reading performance among third and fourth grade primary school students.
- **Temporal Scope:** The study was conducted during the first semester of the 2025 academic year.

1.6. Study Terminology:

- **Phonological Awareness:** Phonological awareness is defined as the ability to observe the sounds present in words and how they combine to form words. Phonological ability, on the other hand, is the learner's capacity to demonstrate phonological awareness in processing the sounds that constitute spoken language and its various phonetic features, such as phonemes

and syllables (Abu Al-Eis, 2009, p. 29). Operationally, within the framework of this study, phonological awareness is defined as the ability to perceive the sounds of spoken letters of the alphabet, how these sounds are integrated to form syllables, words, and sentences, as well as to recognize similarities and differences between them. It also includes the ability to identify and process the sequence and progression of linguistic sounds, words, and sentences. This is determined by the score students achieve on the phonological awareness test used in this study.

- **Working Memory:** Working memory is defined as a dynamic and efficient system capable of processing and preparing information. It is a processing unit through which information is carried, synthesized, and transformed (Baddeley, 2003, p. 835). Operationally, working memory is defined as encompassing the reception, processing, and temporary preparation of information, followed by its storage, retention, recall, and retrieval for use in new situations.
- **Reading Performance:** Reading performance is defined as an intellectual and visual activity accompanied by vocalization and lip movement during oral reading in order to understand the meanings of the ideas conveyed by written symbols, interact with them, and benefit from them (Ibrahim, 2013, p. 19). Operationally, within the framework of this study, reading performance is defined as representing the ability to read words correctly and the time spent reading them.

1.6. Previous Studies:

- The study of “Zayed and Others” (2013). Titled “Phonological Awareness and Working Memory in Arabic-Speaking Egyptian Preschool Children at Risk for Dyslexia”, the study aimed to examine the relationship between phonological awareness and working memory in Arabic-speaking preschool children at risk of dyslexia. The study was applied to 40 children (20 at risk of dyslexia, 20 normal), aged between 5-6 years, The study found a strong relationship between phonological awareness and working memory. It also indicated that both variables may influence phonological awareness and reading skills.
- The study of “Campen, Segers and Verhoeven” (2018). Titled “How Phonological Awareness Mediates the Relation Between Working Memory and Word Reading Efficiency In Children With Dyslexia”, The study aimed to explore whether phonological awareness mediates the relationship between working memory and word-reading efficiency in children with dyslexia. The study sample consisted of 50 children with dyslexia (aged ~9-10 years) and 613 typically developing children (aged ~9-5 years) – a total of ~663 children. The study found that the relationship between phonological awareness and word-reading efficiency was strong ($r = .42$, $p < .001$) overall; and in dyslexic children, working memory was shown to influence reading efficiency via phonological awareness.
- The study of “Oakhill and Kyle” (2000), titled “The Relation Between Phonological Awareness and Working Memory”, The study aimed to compare the strength of the association between working memory (storage and processing tasks) and two phonological awareness skills (sound classification and phoneme deletion) in children approximately 8 years old, and to determine the extent of the relationship to predicting reading. It was found

that working memory (and not just short-term storage) predicted independent variance in phonological awareness tasks; therefore, simple storage tanks were not sufficient.

2. Phonological Awareness:

2.1. The Concept of Phonological Awareness:

Language is a fundamental component of communication, but Meta phonological abilities, or phonological awareness are an important component of the concept of the sound form of language. There are many definitions of phonological awareness, the most prominent of which are:

- It is “the processing and segmentation of spoken language into small units such as syllables, phonemes, or rhymes. This is also achieved through awareness of the phonemic structure of speech” (Hanashi, 2002, p. 865).
- It is “the ability to know where linguistic sounds are produced, how or how these sounds are produced, and how these sounds combine to form words and expressions, with the ability to perceive the similarities and differences between these sounds, whether they occur individually, within words, or in different linguistic expressions” (Masouda, Al-Shaib, and Ismail, 2014, p. 31).
- It is “the knowledge that spoken words are composed of individual sounds and the ability to manipulate these sounds, divide words into smaller units, distinguish word sounds, and rhyme with each word” (Shaib, 2019, p. 323).
- It is “the skills related to the ability to deal with the sound structure of language as distinct from its meaning. Phonological awareness includes listening, phonemic awareness, syllable awareness, and word and sentence awareness”. (Radwan and Adwidar, 2021, p. 119)
- It is “the ability to mentally process speech flows into smaller parts or units. It is a general term that refers to a child's understanding of the linguistic sound structures of language. Phonological awareness develops according to a specific sequence: rhythm, alliteration, words, syllables, onset intonation, rhythm, and phoneme” (Golds Worthy & Pieretti, 2012, p. 02).

Based on the previous definitions, phonological awareness can be defined as the cognitive and mental ability that enables an individual to analyze spoken language into its constituent phonetic units, identify their production sites and formation mechanisms within a word, and be able to distinguish between similar and different sounds and manipulate them consciously, reflecting an awareness of the sound structure of language as a form independent of its meaning. This awareness develops gradually from a sense of rhythm and assonance to accurate recognition of individual sounds within a word.

2.2. Phonological Awareness Development:

2.2.1. Rhyme Awareness Development:

Most children have been observed using "start, rhyme" in spontaneous language exercises. Some four-year-olds are able to recognize rhyme (Zorman, 1999, p. 141). According to the authors of the analogy models, V. Goswami and P. E. Bryant, rhyme is observed at very early stages of reading acquisition, a result of a study conducted on preschool children. In another experiment, V. Goswami demonstrated that non-reading children as young as five or four months old are able to use some analogies when it comes to word rhyme (Casalis and Sprenger-Charolles, 1996, p. 20). Maclean et al. confirmed

its presence in 20% of three-year-olds who studied their rhyme awareness for isolated words (Issoufaly and Primot, 1999, p. 95). Therefore, it can be said that rhyme awareness develops before school age and does not require learning. Reading is not only acquired through verbal exercises, spontaneous language training, and linguistic experiences with the environment.

2.2.2. Syllable Awareness Development:

Syllable development, as well as rhyme formation, is observed at the age of five and four months or four years. This can be achieved through various linguistic experiences, and it can also be acquired implicitly before school age (Zorman, 1999, p. 143). It is a simple sound composition that forms one or more words, each with its own natural respiratory rhythm and the language's lexical structure. Therefore, syllable awareness is recognized before school age. The ease of its recognition stems from its correspondence to a unified speech act, its ease of isolation, or the fact that the syllable is a stable sound unit at the rhythmic level, which allows awareness of this unit to develop early. Even in Arabic, the syllable is considered the smallest structural unit of a word, or the smallest block upon which a speaker can stand. It consists of a number of consonants and vowels accompanied by other phonetic phenomena such as stress and intonation (Al-Sharif, 2000, pp. 167-168).

2.2.3. The development of phoneme awareness:

The development of phoneme awareness requires explicit learning and continuous development with learning to read, unlike non-syllabic sounds, which are not perceived in isolation but are always integrated into the syllable (Sindirian, 1992, p. 15). A long-term study by Gswami suggests that phoneme discovery must be possible until the age of five. According to Ronda and Bredart, between the ages of three and five and a half, children develop sensitivity to the phonetic pitch of language, as they can intentionally distort some words and amuse themselves with others' pronunciation errors by changing or distorting the way the letter sounds of words are pronounced (Van Hout and Estienne, 1998, pp. 41-42). Phonetic analysis often develops through exposure to the alphabetic system, which leads to the development of this skill. Sound is the essence of segmentation and composition. Tongue movements cannot be uttered, nor can they be rhythmic or prose unless sound is present.

Lieberman and others conducted a long study on children aged four and ten months and followed them until the age of six. They administered syllabic and phonetic arithmetic tests. This study concluded that from the age of four, half of the children (46%) successfully completed the syllabic segmentation tests, but only 17% were able to segment into phonemes. By the age of six, the majority of children were able to successfully complete the tests with a significant percentage (90% in syllabic segmentation and 70% in phonetic segmentation) (Issoufaly and Primot, 1999, p. 100). Syllabification is more likely at the age of four, while segmentation into sounds only occurs at six and a half or seven years of age if the child has been exposed to tests that require this type of analysis (Bredart, 1997, p. 29).

The majority of children between one and seven years of age, and even younger, achieve first syllable deletion, but middle deletion remains a problem at the age of twelve (only 45% of children succeed at this age). The same applies to final syllable deletion, which is achieved around the age of seven. Its ease is due to its simple, crossed repetition of the presented word (in two-syllable words, 80% of children aged six to seven succeed). First and final sound deletion occurs at the ages of six and seven, while middle deletion occurs at the end (only a quarter of children succeed at this) (Bertin and others,

1999, p. 79). In general, the ability to use phonological awareness does not appear until the age of six, at the time when writing is understood. This phonological skill does not fully appear except in the case of the child's contact with the form of writing, where this skill is necessary. This means that access to the written symbol does not require a segmental analysis of the phonetic structure of the language. In this direction, "Alegria" explains that contact with the written has a motivating and special character for the emergence of awareness of this segmental structure, and there is no other skill that requires this type of awareness (Issoufaly and Primot, 1999, p. 47).

2.3. Levels of Phonological Awareness:

The levels of phonological awareness include:

2.3.1. Awareness of phonological sequences: This requires individuals to move away from meaning to focus on the form of speech. This awareness appears in children when they attempt to repeat words they hear correctly or when they protest against our imitation. It requires focusing on pronunciation and on prominently perceived units such as rhyme and syllables.

2.3.2. Phonetic Awareness:

Speech is perceived as a series of phonemes, meaning the minimum units that allow for phonetic discrimination. Children begin to master the principle of speech's partial divisibility. Children, before and at the beginning of school, are subject in their discriminative abilities to the phonetic properties of consonants (sensory and phonological), to the articulatory conditions in which consonants are found, and to the ratio of consonant stability in which consonants are identified. Therefore, the analysis of consonants is not influenced by surface factors at this level.

2.3.3. Literal awareness:

This assumes a new shift in the intentional pressures on individuals, where differences in pronunciation or perception and understanding are no longer the important thing, but rather individual differences play a significant role at this level. Unlike phonetic perceptions, perceptions of letters cannot result from simply observing perceived phonetic productions or from mental images of phonological sequences (pronunciation marks), as we can only obtain them by marginalizing phonetic changes. Therefore, phonological awareness requires a special experience that facilitates this abstraction, and reading is undoubtedly a special experience. It is self-evident that, depending on the child's development, he or she can first accomplish certain tasks that call on their analytical abilities in speech processing. These tasks include counting (counting words, syllables, and sounds), segmenting words into smaller and smaller units, then into factors, recognizing rhyme, summarizing factors presented separately, and so on. (Lecocq, 1991, P. 58).

2.4. The Relationship of Phonological Awareness to Reading Comprehension:

In order for a child to learn to read, they must possess a certain knowledge of the structural units of speech, on the one hand, and a specific procedural skill in using them in learning to read. On the other hand, these abilities appear to play a specific role in preparing the child to grasp the beginnings of formal reading learning (Lecocq, 1991, p. 60).

Experimental studies on reading during the last twenties have shown that one of the fundamental determinants of the first historical progress in reading, and at the same time a means of preventing dropout in reading learning, is phonological awareness. Therefore, several studies have indicated a link

between learning to read and the ability to recognize and intentionally use a number of phonological units of oral language (Zorman, 1999, p. 73).

The importance of phonological awareness was attributed to the model of reading acquisition. According to this model, speech is composed of segmental, phonetic units. Thanks to the child's awareness, he understands the alphabetic code, which allows him to establish the relationship between the written form and the child must mentally isolate the phonological units. Other studies confirm the existence of a strong, reciprocal link between the level achieved in reading and phonological competencies. The skills demonstrated in phonological analysis are a good predictor of success in reading (Casalis and Sprenger-Charolles, 1996, p. 20).

The ability to clearly analyze sounds appears to be linked to the recognition of "letter-phonological" correspondence, which undoubtedly plays a very important role in reading acquisition, particularly in decoding new words, compared to word recognition by skilled readers (Combert, 1990, p. 19).

We also note the effects of the phenomenon of learning to read on metaphonological abilities, which are a result of learning to read. Because they constitute prior acquisition, awareness of speech units generally does not develop before the age of six, especially since they are of no use or necessity to the child before this age. Learning the alphabet makes speech analysis necessary and constitutes an excellent setting for activating its development. Language learning also leads the child to gradually build phonological representations and, in some cases, develop analysis skills, which facilitate their understanding of the written system. Learning the alphabet first, then the letter-sound correspondences, allows them to create orthographic representations (Fayol et al., 1992, p. 218). However, the important thing to note is that among the units that cannot develop outside the framework of learning to read from the alphabetical system, and which is considered a simple outcome of this learning, is the phoneme unit. In other words, phonemic analysis and its interaction with the alphabetical system lead to the development of this skill. This is what leads us to say that the analysis of speech into phoneme units does not develop spontaneously (Casalis and Sprenger-Charolles, 1996, p. 20).

Phonological awareness is first and foremost the recognition of the existence of this abstract unit. This existence leads to a degree of interpretive awareness for every speaker of a given language. Furthermore, training in phonological awareness includes the systematic application of oral exercises, which enables the non-reading child to progress very quickly and which encourages learning to read (Lecocq, 1991, p. 80). Phonological awareness only truly develops in relation to learning to read, as it gives segmentational analysis abilities a specific function before reading. The predictive effect of phonological competence is weak before learning to read, while it becomes strong when children begin to learn to read, especially from an inappropriate method. This means that children do not learn in one way, but rather using several methods that allow them to learn many things from the comprehensive method, the phonological method, the synthetic method, and the analytical method. This allows them to form different knowledge about the techniques of learning to read, reading comprehensive words, decoding, sounds, reading a word and then segmenting it into different phonological units so that they can clearly control it to establish the relationship between the spoken and written language (Fayol et al, 1992, p. 213).

3. Working Memory:

3.1. The Concept of Working Memory:

Baddeley and Hirsch were the first to introduce the term working memory as an alternative to the traditional term short-term memory. Working memory is one of the most important factors influencing human behavior, particularly in the learning process. It plays a role as a link between sensory inputs and information in long-term memory. Therefore, it is one of the components of memory that has received the most attention from researchers due to its effective role in information processing. Working memory capacity is one of the most important factors in the variability between individuals, especially in cognitive skills. This variability in memory capacity is evident in the performance of various tasks. Success in performing these tasks is evidence of working memory capacity, but this does not mean that an individual who can successfully perform a particular task will necessarily succeed in performing all other tasks. Among the most prominent definitions provided regarding the concept of working memory are:

- It is “a multi-component system for understanding how information is stored and processed for use in performing various complex cognitive activities” (Bordin, 1994, p. 587).
- It is “a mechanism that acts as a temporary repository for information for a short period of time, and this information is used to generate information” (Solso, 1991, p. 172).
- It is “a mechanism that includes the functional components of perception and helps them comprehend and mentally represent the environment and retrieve previous experiences to support knowledge acquisition, problem solving, and goal formulation” (Baddeley & Hitch, 1994, p. 486).
- It is “an information processing resource with limited storage capacity to retain information during processing, through the immediate temporary storage and manipulation of information, and includes cognitive processes such as comprehension, planning, and reasoning” (Klien and Bisanz, 2000, p. 108).
- It is “a multicomponent, limited-capacity system responsible for processing and storing information necessary for complex tasks such as comprehension, learning, and logical reasoning” (Baddeley A., 2003, p. 831).
- It is “the ability to coordinate mental processes and short-term stored information during cognitive tasks” (Hitch, 2005, p. 311).
- It is “the cognitive system responsible for processing information during cognitive activities such as reading and comprehension” (Gathercole and Holmes, 2014, p. 445).
- It is “a system responsible for temporarily storing and processing information during everyday cognitive activities that require information storage and manipulation and are characterized by limited capacity” (Alloway and Alloway, 2015, p. 232).
- It is “a storehouse of short-term memory contents supplemented by controlled attention” (Hall and Kail, 2001, p. 1).
- It is “a mental component that temporarily stores and processes information in a practical manner for performing complex cognitive tasks such as language comprehension, learning, problem solving, and reasoning” (David and Elizabeth, 2005, p. 355).

Accordingly, working memory can be defined as a limited-capacity, temporary cognitive system that is responsible for simultaneously retaining and processing information during complex mental tasks such as comprehension, learning, and problem solving by coordinating mental processes and employing attention to support efficient cognitive processing.

3.2. Components of Working Memory:

Working memory consists of four components that work together in integration and coordination:

3.2.1. The visual-spatial component:

It is responsible for retaining and processing visual-spatial information. The two subordinate systems are partially distinct in their diversity and task differences, meaning that neither is influenced by the other (Demetriou, Christou, Spanoudis and Platsidou, 2002, p. 9).

3.2.2. The verbal component:

It includes the temporary verbal store, which houses auditory memory pathways that retrieve information within it after a few seconds. It works to retain sequential information. This component evaluates the following simple phenomena:

- **The phonological similarity effect:** In this case, terms such as letters or words that sound similar are more difficult to recall accurately.
- **The word length effect:** Retrieval of short consecutive words is easier than that of long words.
- **The effect of verbal suppression:** This is evident when vocabulary is not retrieved. Suppression eliminates the effect of word length. There is also the transfer of information between codes, as well as the neuropsychological guide.

The verbal component is divided into two subsystems:

- **The articulation control system (verbal repetition):** This system can store information by internally pronouncing it. This component organizes information chronologically and sequentially, and can be considered the internal voice.
- **The phonological store:** This store linguistically based information based on speech. It functions as an inner ear, and information from it fades after 1.5 to 2 seconds. However, the retention of information for a longer period can be controlled by the articulation control system (i.e., by repeating it). The verbal component and the auditory system work together in reading tasks, as the articulation control system is used to convert written material into a linguistic code before recording it in the verbal store.

3.2.3. Central Processor:

The central processor supports the capacity of both the phonological loop and the visual-spatial memory, allocating part of its limited retention capacity to increase the amount of information in the two dependent systems, in addition to coordinating and monitoring their operation (Baddeley, 1990, p. 78)

The central processor is the most important component of working memory, because it organizes the information received in working memory, stores it, processes it, and retrieves information previously stored in other memory types, such as long-term memory. However, the processing resources for this component are limited in capacity, and the central processor performs the following functions (Gathercole and Baddeley, 1990, p. 340):

- Selective attention to a particular stimulus and suppression of the disruptive influence of another.
- Transformation of retrieval strategies, such as those used in random generation tasks.
- Allocation of resources during the simultaneous execution of two tasks (i.e., dual-task coordination).
- Continuous updating of working memory content based on new sensory input.
- Maintaining and processing information stored in working memory.
- Coordinating activity within working memory and governing the transfer of information between other parts of the cognitive system.
- Determines the inputs of the verbal component and the inputs of the visual-spatial component.
- Retrieval of information from long-term memory.

3.2.4. The Event Source Component:

The origins of this component stem from Ericsson and Kintisch's hypothesis that an additional mechanism would, in their view, contribute to explaining the enormous working memory capacity of skilled individuals. They found that some pianists can sing while reading musical scores without any intervention, and that some individuals perform spatial tracking tasks while mentally counting or calculating. This led them to believe that there must be a type of long-term working memory in addition to the well-known short-term working memory. The event source represents a multi-component, coded storage system that collects interconnected events or interconnected scenes. It has limited capacity and intervenes and connects multiple systems that use different codes. This means that it activates multiple sources of information simultaneously, which helps form a clear model of the situation (the task) and then process it. It also processes information from both subsystems and long-term memory, then analyzes the information into large chunks of small numbers to fit the working memory capacity (Sternberg, 2003, p. 161).

3.3. The relationship between working memory and reading comprehension:

Working memory has received considerable attention from researchers regarding its role in language, particularly in reading activities. Memory activity contributes to word recognition and assigning meaning to words. This is accomplished through visual images. Individuals recall visual images to compare new stimuli with previous experience. Information must first pass through the sensory storage system, where it remains for a very short period of time. It then goes to working memory to be encoded and processed, finally passing into long-term memory. Working memory therefore plays a very important role during reading activities. Working memory is responsible for the language and thinking process, and therefore plays a significant role in acquiring and learning reading skills. Baddeley emphasizes the relationship between children's linguistic development and working memory, and that the growth of vocabulary is linked to verbal symbols and also to the ability to store vocabulary within working memory. Continuous word encoding is a hallmark of comprehension (Madouri, 2019, p.60).

Many researchers have confirmed in their studies the extent to which working memory storage capacity affects reading tasks. Carrison, Long, and Dowaliby confirmed that the relationship between working memory capacity and reading activity is direct and does not depend on the nature of the task, and that this working memory storage capacity is what distinguishes good readers from poor readers. In

the same context, we also find a model proposed by Daneman and Carpenter, which indicates that individuals with good reading comprehension and those with poor reading comprehension do not differ in their working memory capacity, but rather in the effectiveness of their information processing, especially in terms of controlling attention and resisting distraction. From here, we conclude that working memory represents the individual's central processing unit, especially with regard to language skills, and reading in particular. It would be logical to think that there is a relationship between working memory activity and reading learning difficulties (Madouri, 2019, pp. 60- 61).

4. Methodological Procedures:

4.1. Study Methodology:

The study adopted a descriptive-analytical approach with a correlational focus. Its aim was to analyze the relationship between the study variables (phonological awareness, working memory, and reading performance) among third and fourth grade primary school students. The goal was to determine the extent to which the independent variables (phonological awareness and working memory) influence reading performance as a dependent variable. This approach was chosen because it is the most suitable for studying psychological and educational phenomena. It allows for a precise description of the phenomenon and the analysis of correlational relationships between variables using appropriate statistical methods such as correlation coefficients and multiple regression.

4.2 Study Population and Sample:

The study population consisted of all primary school students in Ain Fakroun, Oum El Bouaghi Province, Algeria, during the 2025/2026 academic year. A random sample of 200 male and female students from the third and fourth grades (ages 8-10) was selected from this population. The sample was drawn from three primary schools in Ain Fakroun, including the 20 August School. 1955, a school in the Wadi district, and the Siya Tayeb School.

4.3 Research Instruments:

The study relied on three main instruments, developed or adapted to measure the three research variables:

- **Phonological Awareness Test:** This test aims to measure students' awareness of linguistic sounds through tasks related to recognizing, analyzing, and combining sounds into words. The test consists of 10 items.
- **Working Memory Test:** This test aims to measure students' ability to retain and process information simultaneously. This is a fundamental cognitive skill related to reading performance. It consists of 10 items.
- **Reading Performance Test:** This test aims to measure students' reading performance in terms of accuracy, comprehension, and reading speed. The test includes 10 items.

4.4. Validity and Reliability Coefficients (Cronbach's Alpha):

To verify the internal consistency and reliability of the study instruments, Cronbach's alpha coefficient was calculated for each of the three measures: the phonological awareness test, the working memory test, and the reading performance test. Cronbach's alpha coefficient is typically used to assess internal consistency among measure items, with a value of 0.70 or higher generally considered acceptable and indicative of good reliability, Table (1): Validity and Reliability Coefficients (Cronbach's Alpha):

Table (1): Validity and Reliability Coefficients (Cronbach's Alpha)

Tests	Number of Items	Alpha Coefficient
Phonological Awareness Test	10	0.915
Working Memory Test	10	0.836
Reading Comprehension Test	10	0.818

Source: Prepared by the researcher according to SPSS outputs

As shown in the results, all three scales achieved high reliability coefficients, with Cronbach's Alpha values ranging from 0.818 to 0.915. These values indicate a strong internal consistency among the items within each scale, confirming that the measurement instruments used in this study are highly reliable. Consequently, the data collected can be considered consistent and dependable for subsequent statistical analyses and interpretation.

5. Study Results and Discussion:

5.1. Testing The Study's Hypotheses:

5.1.1. Testing The First Hypothesis:

The first hypothesis states that **"There is a statistically significant relationship at the (0.01) level between phonological awareness, working memory and reading performance among primary school students"**. To test this hypothesis, we conducted the following tests:

- Descriptive Statistics:

Descriptive statistics were calculated to summarize the overall trends and characteristics of the participants' responses across the three main constructs: phonological awareness, working memory, and reading performance. The analysis provides information about the minimum, maximum, mean, and standard deviation values for each variable, offering a general overview of the data distribution and central tendency, Table (2) shows the statistical values of these variables:

Table (2): Statistical values of the study variables

Study variables	Minimum	Maximum	Mean	Std. Deviation
Phonological Awareness	20.00	32.00	27.215	4.04979
Working Memory	18.00	32.00	25.950	4.33027
Reading performance	18.00	44.00	26.5750	4.56603

Source: Prepared by the researcher according to SPSS outputs

The descriptive analysis of the study variables revealed that the mean phonological awareness score was 27.215 with a standard deviation of 4.04979, ranging from 20 to 32. This indicates a relatively high level of phonological awareness among the participants, with moderate variation. The mean working memory score was 25.950 with a standard deviation of 4.33027, ranging from 18 to 32. This reflects an average to good level of working memory abilities among the participants, with moderate individual differences. Reading performance ranged from 18 to 44, with a mean of 26.575 and a standard deviation of 4.56603. This indicates that the reading performance level falls within the average range, with

relatively significant variation among the individuals. In general, the results show that average phonological awareness was the highest among the study variables, followed by reading performance and then working memory, which may be explained by the fact that developing phonological awareness contributes to improving the reading performance of students.

- Correlation Analysis:

Pearson's correlation coefficient was computed to examine the relationships among the three main constructs: phonological awareness, working memory, and reading performance. The analysis aimed to identify the strength and direction of the associations between these variables, Table (3) shows Pearson correlation coefficient between study variables:

Table (3): Pearson correlation Coefficient Between Study Variables

Correlations				
		Ph_Total	WM_Total	Read_Total
Ph_Total	Pearson Correlation	1	.661**	.685**
	Sig. (2-tailed)		.000	.000
	N	200	200	200
WM_Total	Pearson Correlation	.661**	1	.853**
	Sig. (2-tailed)	.000		.000
	N	200	200	200
Read_Total	Pearson Correlation	.685**	.853**	1
	Sig. (2-tailed)	.000	.000	
	N	200	200	200

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Prepared by the researcher according to SPSS outputs

As shown in Table (3), all correlations among the study variables were positive and statistically significant at the 0.01 level. Phonological awareness was significantly and strongly correlated with working memory ($r = .661$, $p < 0.01$) and with reading performance ($r = .685$, $p < 0.01$). Likewise, working memory exhibited a very strong and significant correlation with reading performance ($r = .853$, $p < 0.01$). These results suggest that higher levels of phonological awareness and working memory are associated with enhanced reading performance. The findings corroborate previous research highlighting the crucial interdependence between phonological processing and working memory in the development of reading skills.

5.1.2. Testing The Second Hypothesis:

The second hypothesis states that **“there are statistically significant differences at the (0.05) level in reading performance attributable to demographic variables (gender and grade level) among primary school students”**.

To determine whether there were statistically significant differences in reading performance levels attributable to gender and grade level, an independent samples t-test was used to compare students' average reading performance scores according to gender (male/female) and grade level (third/fourth

grade), The table (4) shows the means and standard deviations for each group according to these two variables:

Table (4): T- Test

Variable	Group	N	Mean	Std. Deviation
Gender	Male	108	26.5556	4.70898
	Female	92	26.5978	4.41790
Grade	Grade 3	100	23.1100	3.90259
	Grade 4	100	30.0400	1.55648

Source: Prepared by the researcher according to SPSS outputs

The table (4) shows that the average reading performance score for males ($M = 26.56$) is not significantly different from that of females ($M = 26.60$), initially indicating no substantial gender difference in this variable.

However, regarding grade level, a clear difference emerged between third-grade students ($M = 23.11$) and fourth-grade students ($M = 30.04$), indicating that fourth-grade students outperformed fourth-grade students in reading performance.

The results of the t-test confirmed that this difference was statistically significant at the 0.01 level in favor of fourth-grade students, while the gender differences were not statistically significant ($p = 0.948$). This can be explained by the fact that progressing through the grade contributes to improved reading skills as a result of acquiring more experience and cognitive and linguistic training, while gender did not appear to have a clear effect in this regard.

5.1.3. Testing The Second Hypothesis:

The third hypothesis states that **“phonological awareness and working memory contribute to predicting reading performance among third and fourth grade elementary school students”**.

To examine the extent to which phonological awareness and working memory predict reading performance among the participants, a multiple regression analysis was conducted. The results presented in Table (5) summarize the model fit indices, the overall significance of the regression equation, and the contribution of each independent variable to the prediction of reading performance.

Table (5): Multiple Linear Regression Analysis

Model	R	R ²	Adjusted R ²	Std. Error of Estimate	Predictors	β	Std. Error	Beta	T	Sig	F
1	0.869	0.754	0.752	2.27441	Constant	0.511	1.145	-	0.447	0.656	302.5
					Phonological Awareness	0.243	0.053	0.215	4.577	0.000	

					Working Memory	0.75 0	0.05	0.71 1	15.10 7	0.00 0	
--	--	--	--	--	-------------------	-----------	------	-----------	------------	-----------	--

Source: Prepared by the researcher according to SPSS outputs

The results of the multiple regression analysis presented in Table (5) indicate that the overall model predicting reading performance from phonological awareness and working memory was statistically significant, $F(2, 197) = 302.5$, $p < 0.001$. The model explained approximately 75.4% of the variance in reading performance ($R^2 = 0.754$), suggesting a strong predictive power of the independent variables combined. Both predictors contributed significantly to the model; however, working memory emerged as the stronger predictor ($\beta = 0.711$, $t = 15.107$, $p < 0.001$) compared to phonological awareness ($\beta = 0.215$, $t = 4.577$, $p < 0.001$). These findings indicate that students with higher levels of working memory and phonological awareness tend to achieve better reading performance. The results highlight the pivotal role of cognitive processes, particularly working memory, in supporting reading development.

6. Results and Recommendations:

6.1. Results:

- The participants demonstrated average to high levels of phonological awareness, working memory, and reading performance.
- A strong positive correlation was found between phonological awareness and working memory ($r = 0.661$, $p < 0.01$), between phonological awareness and reading performance ($r = 0.685$, $p < 0.01$), and between working memory and reading performance ($r = 0.853$, $p < 0.01$).
- Multiple regression analysis showed that the overall model was statistically significant ($F = 302.517$, $p < 0.001$), with a coefficient of determination ($R^2 = 0.754$), meaning that the two independent variables (phonological awareness and working memory) explained 75.4% of the variance in reading performance.
- Working memory proved to be the strongest predictor of reading performance ($\beta = 0.711$, $t = 15.107$, $p < 0.001$), followed by phonological awareness ($\beta = 0.215$, $t = 4.577$, $p < 0.001$).
- No statistically significant differences in reading performance were found attributable to gender ($p = 0.948$).
- Statistically significant differences in reading performance were found between third- and fourth-grade students, favoring fourth-grade students ($p < 0.001$).

6.2. Recommendations:

- Integrate regular training activities to develop phonological awareness into early childhood reading programs in primary schools.
- Focus on developing verbal and visual working memory through educational strategies based on language games and mental training.
- Develop educational intervention programs for learners with weak reading performance, focusing on aspects of phonological processing.

- Provide teachers with professional development in how to link reading skills to basic cognitive processes (memory, attention, and phonemic awareness).
- Conduct future studies examining the relationship between phonological awareness and working memory at different age levels and in other languages to confirm the generalizability of the findings.
- Introduce standardized diagnostic measures of phonological awareness and working memory into the psychological and educational assessment tools used in schools.

7. References:

- Al-Ais, Ismail. (2009). The Relationship Between Phonological Awareness and Reading Ability Level Among Primary School Students with Reading Difficulties. Arab Childhood Journal, Kuwait. 10(38). pp. 28-46.
- Alloway, T; Alloway, R. (2015). Understanding Working Memory. Los Angeles: Saga.
- Al-Sharif, Mihoubi. (2000). The syllable and the structure of the word. Revue Des Sciences Humaines, 11(2), PP. 167-177.
- Baddeley, A. (2003). Working Memory: Looking Back and Looking Forward. Nature Reviews Neuroscience, 4(10), PP. 829- 839.
- Baddeley, A. D. (1990). Human Memory: Theory and Practice. Hillsdale: Lawrence Erlbaum.
- Baddeley, A. D.; Hitch, G. J. (1994). Working Memory. In G. A Brower (Ed.), Recent Advances in Learning and Motivation. New York: Academic press.
- Bertin, G; Retailleau, I; Conzalez, C. (1999). Approche Rééducative De La Conscience Phonologique D' Une Enfant Présentant Une Dysphasie Et une Dyslexie. Rééducation Orthophonique, 197.
- Bordin, E. S. (1994). Working Memory Corsisn R. (ed), Encyclopedia of Psychology. Ed 3, New York.
- Bredart, S; Rondal, J.A. (1997). L' Analyse Du Langage Chez L' Enfant: Les Activités Métalinguistique. Margada.
- Campen, Carolien A N Knoop-van. Segers, Eliane. Verhoeven, Ludo. (2018). Phonological Awareness and Working Memory in Arabic-Speaking Egyptian Preschool Children at Risk for Dyslexia. PubMed Center. 24(2). pp. 156- 169.
- Casalis, Séverine; Sprenger-Charolles, Liliane. (1996). Lire. Lecture Et Ecriture: Acquisition Et Troubles Du Developpement. PUF.
- Combert, J.E. (1990). Le Développement Métalinguistique, Edition PUF.
- David, A.; Elizabeth, J. (2005). Cognitive Psychology: Key Readings. New York: Psychology Press.
- Demetriou, Andreas; Christou, Constantinos; Spanoudis, George and Platsidou, Maria. (2002). Monogr Soc Res Child Dev, 67(1).
- Fayol, M. et al. (1992). Psychologie Cognitive De La Lecture. Paris: PUF.

- Gathercole, S. E.; Baddeley, A. D. (1990). Phonological Memory Deficits in Language Disordered Children: Is There A Casual Connection?. *Journal of Memory & Language*, PP. 336- 360.
- Gathercole, S.; Holmes, J. (2014). Taking Working Memory Training from The Laboratory into Schools. *Educational Psychology*, 34(4), PP. 440- 450.
- Hall, Lynda K.; Kail, Robert. (2001). Distinguishing Short-Term Memory from Working Memory. *Memory & Cognition Journal*, 29(1), PP. 1- 29.
- Hanachi, Souad. (2002). A Study of the Effect of Phonological Awareness on Spelling Through a Treatment Program Targeted at Students with Phonological Writing Disabilities. *Journal of the University of Psychological Studies and Educational Sciences*, 7(2), pp. 860-889.
- Hitch, G. (2005). Working memory. In N. Braisby and A. Gellatly (Eds.), *Cognitive Psychology*. New York: Oxford University Press.
- Ibrahim, Sulaiman Abdul Wahid. (2013). *Reading Comprehension Difficulties Among Students with Learning Disabilities*. Amman: Dar Al-Warraq for Publishing and Distribution.
- Issoufaly, M; Primot B. (1999). Matériel D' Entrainement De La Compétence Méta-Phonologique. *Rééducation Orthophonique*, 197.
- Klien, J. S.; Bisanz, J. J. (2000). Preschoolers Doing Arithmetic: The Concepts Are Willing but The Working Memory is Weak. *Journal of Experimental Psychology*, 54(2), PP. 105-116.
- Lecocq, Pierre. (1991). *Apprentissage De La Lecture Et Dyslexie*. Éd. Mardaga.
- Madouri, Yamina. (2019). Working memory in people with learning disabilities. *Integration Journal*, 3(7), pp. 48-67.
- Masouda, Montaser; Al-Shaib, Muhammad Sami; Ismail, Al-Aiss. (2014). Phonological Awareness in Children with Reading Disabilities: Field Data from Some Primary School Students. *Journal of Humanities and Social Sciences*, 15, pp. 25-35.
- Oakhill, J. Kyle, F. (2000). The Relation Between Phonological Awareness and Working Memory. *J Exp Child Psychol*. 75(2).
- Radwan, Muhammad; Adwidar, Radwan. (2021). Phonological awareness level in children with autism spectrum disorder and their typical peers. *Journal of Special Education*, 11(37), pp. 102-131.
- Golds Worthy, C.; Pieretti, R. (2012). *Sourcebook of Phonological Awareness Activities*. New York: Cengage Learning.
- Shaib, Ahmed Muhammad. (2019). Phonological Awareness and Its Relationship to Self-Confidence and Achievement Motivation among Primary School Students with Learning Disabilities. *Journal of Educational and Psychological Sciences*, 20(1), pp. 319-353.
- Sindirian, L. (1992). L' Analyse Segmentale De La Parole Et Apprentissage De La Lecture Chez Des Elèves De C.P, CE1, CE2, *Revue Française Pédagogique*,
- Solso, R. L. (1991). *Cognitive Psychology*. Ed 2. New York: Allyn and Bacon.
- Sternberg, R. (2003). *Cognitive Psychology*. Thomson: Words Worth Australia.

- Van hout, A; Estienne, F. R. (1998). Les Dyslexie, Ecrire; Evaluer Expliquer Et Traiter.
- Zayed, Amal. Roehrig, Alysia. Gilgil, Nasra and Liody, M Arrastia. (2013). Phonological Awareness and Working Memory in Arabic-Speaking Egyptian Preschool Children at Risk for Dyslexia. International Journal of Psychological Studies. 5(1).
- Zorman, M. (1999). Evaluation De La Conscience Phonologique Et Entrainement Des Capacités Phonologique En Grand Section Maternelle. Rééducation Orthophonique, 197.